Tanta University Faculty of Engineering Elec. Power and Machines Eng. Depart. Third year	Generation and economy of electrical energy Sheet No. 3

1. **The input fuel for a generating unit in millions of (Btu/h) is given as a function of the output power in MW as: $F = (120+5.8P+0.032P^2)$. Develop an expression for incremental fuel cost in \$/MWh as a function of the generated power in MW based on a fuel cost of 2 \$/MBtu. Also, calculate the average cost of fuel per MWh when the generated power is equal to 200 MW.**

2. **Two generators have minimum and maximum capacity of 20 and 125 MW respectively. The incremental fuel costs in \$/MWh for units are given by:** $\frac{dF_1}{dP_1} = 0.02P_1 + 4$ and $\frac{dF_2}{dP_2} = 0.025P_2 + 3$

   Solve for optimal allocation if the supplied by load is 220 MW and calculate the additional cost if the two units share the load equally (i.e. $P_1=P_2=110$MW).

3. **A load of 300 MW is supplied by two 200 MW units with incremental fuel costs in \$/MWh as follows:** $\frac{dC_1}{dP_1} = 0.1P_1 + 20$ **and** $\frac{dC_2}{dP_2} = 0.12P_2 + 15$.

   Determine the most economic division of load between the two units and the extra cost if equal load sharing is used.

4. **The cost function of four generating units in \$ are as follows:**

   $F_1 = 0.006P_1^2 + 9P_1 + 120$ $\qquad$ $F_3 = 0.004P_3^2 + 8P_3 + 110$

   $F_2 = 0.0048P_2^2 + 6P_2 + 130$ $\qquad$ $F_4 = 0.0034P_4^2 + 10P_4 + 140$

   Find the incremental fuel costs λ of the plant and the required output of each unit to achieve economical operation assuming a total load of: a) 750 MW, b) 900 MW and c) 1000 MW.

5. **In problem 4, assume minimum and maximum capacities of the four units in MW as follows: unit 1: 50 and 250, unit 2: 100 and 4500, unit 3: 80 and 300, and unit 4: 110 and 300. Recalculate the incremental fuel costs λ of the plant and the required output of each unit.**

6. **The incremental fuel costs in \$/MWh for 3 generating units are given as:**

   $\frac{dC_1}{dP_1} = 0.009P_1 + 3$ $\qquad$ $\frac{dC_2}{dP_2} = 0.012P_2 + 3$ $\qquad$ $\frac{dC_3}{dP_3} = 0.008P_3 + 3.6$

   The minimum and maximum loads on each unit are respectively 100 and 350 MW and the load demand is 800 MW. The loss formula is given

   $P_{loss} = 0.00014P_1^2 + 0.00008P_1P_2 + 0.00009P_2^2 + 0.0001P_3^2 + 0.0001P_2P_3$,

   where P is in MW. Find the optimal load allocation among the generators using only two iterations. Start with a Lagrange multiplier value of 6 and penalty factors of unity.